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UNITED STATES READINESS COMMAND

VALIDATION OF CLOSE AIR SUPPORT (CAS) PHASE II RESULTS FINAL REPORT

EXECUTIVE SUMMARY

(This protective marking is cancelled on 1 May 1979)

APRIL 1976

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PART I

GENERAL

1. PURPOSE. The Close Air Support Validation Program was directed by the Deputy Secretary of Defense in January 1973 to reduce areas of uncertainty in the Joint Staff Task Force Close Air Support Study, Phase II, November 1972 (hereafter JSTF Study), that pertained to Service command and control of Close Air Support (CAS) and Attack Helicopter Support (AHS). This direction tasked the JCS to conduct CAS validation to answer OSD-prescribed objectives through collection of data during joint training exercises. JCS tasked USREDCOM in coordination with LANTCOM to develop and conduct the program assisted by the Weapons System Evaluation Group on an independent basis. This part summarizes the USREDCOM/LANTCOM Final Report of CAS Validation, submitted in nine volumes. Volume I contains data pooled from applicable exercises, the complete analysis, and conclusions. Volumes II-VIII contain data from each exercise, and Volume IX describes equipment and procedures.

2. EXERCISE ENVIRONMENT.

a. Collection of quantitative data and subjective information from participants was accomplished during the period June 1974 - June 1975 on the following USREDCOM, LANTCOM, USEUCOM exercises.

EXERCISE	DATES	SPONSORING COMMAND	SERVICE PARTICIPATION
BRAVE CREW 74	17-21 Jun 74	USREDCOM	A, AF
EXPRESS CHARGER	9-17 Jul 74	LANTCOM	MC
BRAVE SHIELD IX	30 Jul-5 Aug 74	USREDCOM	A, AF
REFORGER 74	10-20 Oct 74	USEUCOM	A, AF
GALLANT SHIELD 75	18-23 Apr 75	USREDCOM	A, AF
AGATE PUNCH	20-28 Apr 75	LANTCOM	N, MC
SOLID SHIELD 75	30 May-6 Jun 75	LANTCOM	N, MC, A, AF

b. All exercises combined employed 524 fixed wing aircraft and 87 attack helicopters. CAS/AHS data were generated during some 17 to 30 exercise days (depending on Service), involving a total output of over 5000 fighter/attack and helicopter sorties. Approximate indicators of CONUS exercise activity are as follows. Approximate numbers of exercise days of CAS/AHS employment are shown in parentheses.

EXERCISE DATA

SERVICE	FTX DAYS	FEBA LENGTH (NM)	AVG NO. AIRCRAFT	BASING DISTANCE (NM)	SORTIES TOTAL	SORTIES CAS/AHS
AF	22 (21)	10-30	77	40-240	2521	1074
A	21 (19)	10-30	16	2-30	(1140)	1140
MC	26 (17.5)	12	32	1-120	(788)	788
N	17 (6.5)	12	80	70-120	702	294

The sortie to CAS/AHS mission conversion is based generally on one to two aircraft per mission. Sortie figures in parentheses are estimates because data available were incomplete for the total air effort during the exercises.

c. Exercise constraints and artificialities had a major impact on CAS validation including:

(1) The limited ground maneuver constraints/restrictions on off-road vehicle operation and full use of terrain and cover.

(2) Limited size of maneuver area and forces employed restricted the potential for flexible employment and massing of air assets for large scale operations.

(3) Environmental constraints inhibited ground dispersal and camouflage.

(4) No live ordnance was employed (except a limited EXPRESS CHARGER sample).

(5) Target marking and laser designation were not authorized.

(6) Airspace management constraints and limited exercise space over the ground maneuver area contributed to fixed wing queuing delays in the transit phase. These included civil air traffic control procedures, peacetime separation and weather minimum restrictions, and exclusion/restricted areas established around fixed wing airstrikes for safety reasons.

(7) CAS Validation methodology introduced artificialities which impacted network performance. These included simulations and unusual tasking.

(8) Electronic Counter Measures (ECM) were limited in terms of forces; frequency coverage; safety protection of air-ground/radar frequencies; and Meaconing, Intrusion, Jamming, and Interference (MIJI) employment.

3. CAS VALIDATION OBJECTIVES. The CAS Validation Objectives directed by OSD are cited verbatim as follows:

a. Objective No. 1 - Response Time. Determination of response times for immediate demands on the close air support (CAS) command and control system, including transmission, processing, and transit times.

b. Objective No. 2 - Communication Requirements. Determination of communication requirements, both ground and airborne, at all levels, including secure transmission needs.

c. Objective No. 3 - Integration. Determination of the capability to integrate CAS with other tactical operations in the combat area, including the consideration of fire support coordination, air defense, and airspace control functions.

d. Objective No. 4 - Capacity. Determination of maximum system capacity to handle target attacks under clear weather conditions.

e. Objective No. 5 - Training. Determination of training requirements for qualification and annual maintenance training of observers, air controllers, and operators for each level above company. Determination of training requirements for combat battalions and tactical air control system units in terms of CAS sorties per year.

f. Objective No. 6 - Night/Reduced Weather. Determination of the degradation of the system's ability to provide effective command and control of CAS at night, in bad weather, or under artificially reduced visibility.

g. Objective No. 7 - Target Acquisition. Determination of the ability of various CAS target acquisition systems to detect and identify hostile targets and hand-off these targets to an attacking agent.

h. Objective No. 8 - Damaged Elements. Determination of the extent of system degradation resulting from damage to individual elements.

i. Objective No. 9 - Intelligence/Friendly Information. Determination of the functioning of intelligence information and friendly data availability as aids in decision-making within the command and control system. Examine information requirements, accuracies, and times involved in entering it in the system and making decisions based on it.

j. Objective No. 10 - Compatibility/Interoperability. Determination of the compatibility and interoperability of the elements of the CAS command and control system.

k. Objective No. 11 - New/Improved Equipment. Evaluation of the improvements offered by new/improved equipment in the other test objectives.

Subsequent JCS approved guidance recognized the limitations in addressing these objectives through this program, particularly with reference to capacity, target acquisition, intelligence/friendly information, and compatibility/interoperability. Training was assigned as a Service responsibility.

4. VALIDATION METHODOLOGY:

a. Program test design evolved to specify that CAS/AHS validation would be accomplished by manual data collection, augmented by radio net voice recordings and player logs. Exercise data were used to determine the elapsed times of immediate CAS/AHS request histories and "success/failure" or degradation measures (delays, disapprovals, cancellations, and aborts) associated with each.

b. Field data collection was accomplished by a Joint Validation Headquarters (JVH) augmented by Service components to a maximum strength of 340 personnel. Data from manual forms were computerized by The BDM Corporation to produce program statistics and reviewed by a board of senior Service officers assigned to the project.

c. These data from request histories were supplemented by subjective comments from participants and by available supplemental information provided by the Services. Planned use of the Range Measuring System (RMS-2) terminal area three dimensional position measurement was discarded because of support costs, degradation of exercise training objectives, insufficient equipment to predict probable engagement of RMS-2 equipped aircraft and targets, and relevance of data to command and control performance.

d. Program costs, including some indirect support costs borne by the Services, totaled about $4.5 million of which $2.7 million was funded by DDR&E FY 74-76 appropriations.

e. Characteristics of the data reported herein were as follows:

(1) Requests were categorized as "Disapproved" (by higher authority), "Cancelled" (by requestor), or "Flown." Flown missions were "complete" (sufficient "horizontal" (H) data from request initiation to first weapon release), or "incomplete" (missing data - unavailable or artificial). Valid segments from "incomplete" missions were included in "aggregate" (A) element-to-element link statistics.

(2) Requests were also categorized as "base case" (typical conditions intended neither to improve nor degrade performance), or by "deviation" conditions. "Cumulative" identifies data from all exercise conditions combined.

EXERCISE CONDITIONS

BASE CASE	DEVIATION CONDITIONS
Daylight conditions	Night conditions
Good weather/visibility	Reduced weather/visibility
No damage to network elements	Damaged network elements
No secure voice	Secure voice
Standard equipment	New equipment
Limited enemy air threat	Substantial enemy air threat
Limited enemy air defense threat	Substantial enemy air defense threat
Target poor environment	Target rich environment
No ECM threat	ECM threat
Adequate intelligence	

(3) Network "Paths" were designated to identify elements involved, asset decision/control level, and asset alert posture (air/ground/divert) for each request/mission. Requests were classified by some 150 CAS mission variables including these paths.

(4) Elapsed time statistics were generated for total mission response time, constituent element-to-element links, request phase processing and communication times, and transit and terminal controller-to-target times (which included both processing and communication).

(5) Delay statistics were developed on elapsed time effects and causes and frequencies of 54 types of delays reported by data collectors. Similarly disapproval, cancellation, and abort statistics were developed on reasons reported. Exercise constraints as well as operational factors were reflected in these causes/reasons, although element links with known artificialities ("safety," "administrative hold," "controller hold") were discarded.

f. Three types of quantitative analysis were employed. "Standard" analysis used descriptive statistical techniques including computation of derived statistics from a distribution fitted to these samples. Regression analysis was employed to account for primary causes of elapsed time variation. "Sub-sample" analysis was employed to achieve a better fit of the pooled data to population statistics distributions (Weibull). REFORGER 74 was excluded from pooled data due to extreme exercise constraints.

g. Subjective comments are summarized in Part V and were employed to augment analysis of the data, both in terms of explaining the data and supplementing it with available information external to the data collection. HQ USAF provided information from combat records and on programmed command and control improvements.

h. This report contains comparisons of CAS exercise information obtained to address the CAS Validation Objectives, with JSTF Study estimates relative to the 15 criteria and criterion measures employed in that study. It is emphasized that the CAS Validation Program was not designed to address completely these criteria due to differing scope and methodology and the impact of exercise constraints. Relative to JSTF Criterion No. 1 Response Time - Immediate Mission, the JSTF intuitively estimated most likely, optimistic, and pessimistic times for each discrete activity within the network. Based on these estimates, an estimate of expected value and variance was calculated for each activity. These values were then summed for the appropriate activities for a given path. The JSTF also estimated processing, communication and transit times for each path. All estimates were based on specific NATO and Korean scenarios, and assumed optimal airspace utilization and target distribution.

5. SUMMARY. The purpose, exercise environment, objectives, and methodology of the CAS Validation Program have been summarized above. While the exercise environment was characterized by numerous constraints, it was considered to be more realistic as a vehicle involving free play of joint forces than any controlled test to date. The validation methodology involved reflects the adjustments of actual data collection on a relatively non-priority basis. Parts II, III, and IV that follow summarize the results of analysis of CAS validation information for each Service command and control network.

PART II

ARMY/AIR FORCE COMMAND AND CONTROL NETWORK
FOR CLOSE AIR SUPPORT

1. GENERAL. Following is a summary of data and analysis of Army/Air Force Network (primarily USAF Tactical Air Control System - TACS) performance using data pooled from CONUS joint exercises and subjective inputs. Data from REFORGER 74 were used when feasible, but were generally excluded because of artificial delays in the request phase.

2. DATA INVENTORY. Of 754 cumulative requests for immediate CAS (548 - SOLID SHIELD 75 and GALLANT SHIELD 75), 196 were disapproved, 55 cancelled, 19 missing data to preclude classification, and 484 flown. Of the 484 flown missions, 387 total cumulative missions included complete data. Of these complete missions, 195 were base case, and the remaining 192 were accomplished under deviation conditions. About 80 percent of the total were daylight visual CAS missions against vehicle targets employing Air FAC control. Adequate samples of Ground FAC controlled and specialized night/weather missions were obtained.

3. ANALYSIS BY OBJECTIVE.

a. Objective No. 1 - Response Time. Total mission response time for all 387 cumulative missions averaged 24.8 minutes (15.5 minutes for the 98 missions without delays). Total base case missions averaged 22.8 minutes (14.9 minutes without delays). DASC Air Alert (Path 4) provided the fastest response, averaging 18.5 minutes for the total and 12.1 minutes for those missions without delays. The learning curve effect was demonstrated by the SOLID SHIELD 75 cumulative and base case samples without delays, which averaged 12.1 and 11.1 minutes respectively. Significant variance in the times was attributable primarily to delays, which affected 75 percent of the cumulative samples and 67 percent of the base case missions. Principal causes (explained in analysis for the other objectives) were exercise constraints and factors related to processing, communications, and integration. The data confirmed the ability to control response time through posturing of assets and were supported by extensive Southeast Asia documentation cited in the report.

b. Objective No. 2 - Communication Requirements. Relative to the two pertinent deviation conditions, secure voice operation was not implemented and ECM play was limited. Communication related delays accounted for the largest single incidence of delay and affected 40 percent of the total cumulative missions, with an average time effect of about five to seven minutes. These delays occurred primarily in the Air Request Net, and were caused by use of alternate communications, occasional saturation, and delays in establishing contact. Although delays were a problem, the insignificant incidence of communication caused disapprovals, cancellations, and aborts, reflects that the network functioned. USAF Tactical Air Control System (TACS) communication modernization is expected to solve many of the problems encountered. Secure voice and Electronic Counter-Counter Measures (ECCM) systems under development should further enhance the TACS communication capabilities.

c. Objective No. 3 - Integration. Data on the two pertinent deviation conditions, air threat and air defense threat, were essentially similar to the base case, due primarily to exercise constraints impacting on realistic play. Integration related delays affected 44 percent of the cumulative missions an average of about nine minutes, but if aircraft position and terminal controller effects (largely conditioned by exercise constraints) are excluded; about 30 percent of these missions were affected. Primary remaining delay causes were associated with Army decision in the Direct Air Support Center (DASC), ground authority clearance in the terminal area, procedural delay, and coordination related delay. Overall integration of CAS with fire support coordination, airspace management, and air defense was satisfactory. The problems cited in paragraph 3j indicate areas for improvement.

d. Objective No. 4 - Capacity. Because of exercise constraints, no attempt was made to test maximum system capacity. The "Target Rich" periods during GALLANT SHIELD 75 demonstrated the capability to accommodate DASC processing of 24 requests in an hour (which included peak rates of up to 35 requests per hour), and 107 per day with little added delay. The peak visual terminal control was nine in one hour (constraints notwithstanding), and the total average terminal controller-to-target time of 4.5 minutes would support 13 missions per hour in a brigade front (20 km). Through the CONUS program, the Air Force provided about 1,000 immediate CAS sorties, an average of 13 per day for each of the two to six battalions supported. Capacity-related delays, which affected 31 percent of the missions, were largely occasioned by exercise factors. Overall, the capability to mass force was not tested; nevertheless, exercise activity levels supported JSTF estimates.

e. Objective No. 5 - Training. While this objective was not addressed, levels of training observed were reflected in network performance. CAS validation data were considered useful to highlight training requirements.

f. Objective No. 6 - Night/Reduced Weather. Despite exercise constraints on employment of night and all weather systems, the data confirmed improved capabilities for operations during these conditions. The Air Support Radar Team (ASRT), F-111 radar/beacon bombing, AC-130 sensor directed acquisition and attack, and a limited sample of visual operations using flares demonstrated these capabilities; however, response times for ASRT and F-111 were slower, with greater delay effects, and indicated areas requiring procedural improvement and practice.

g. Objective No. 7 - Target Acquisition. The lack of target marking and designation constrained the system performance. Target acquisition related delays ostensibly affected 25 percent of the cumulative total missions. Excluding terminal controller availability and position factors, these delays affected only 11 percent of the missions. Incidence of target identification delay itself was less than four percent. Effective target visual acquisition and hand-off were demonstrated; however, the timeliness and accuracy of specialized target information for F-111 and ASRT missions required improvement. USAF action is in progress to modernize target acquisition and hand-off through laser, infra-red, and electronic sensor designation methods.

h. Objective No. 8 - Damaged Elements. Data confirmed the essentiality of Tactical Air Control Party (TACP) equipment, although alternate methods of communication were effective, and demonstrated the interchangeability of the Control and Reporting Center (CRC) and the Control and Reporting Post (CRP). DASC outage, however, indicated a requirement for more emphasis on alternate DASC procedures to reduce delays and confusion. General malfunctions in the network elements were not a significant factor.

i. Objective No. 9 - Intelligence/Friendly Information. Data collection was limited to target information and enemy/friendly position information delays associated with specific requests. Incidence of such delays affected only seven percent of the total missions. Subjective input indicated that a broad range of USAF reconnaissance/intelligence programs, such as COMPASS SIGHT, COMPASS EARS, COMFY LEVI, and Sensor Reporting Post, provided useful near real time support of decision makers.

j. Objective No. 10 - Compatibility and Interoperability. No delays related to communications incompatibility were noted. Interoperability was not tested, but several programs are in progress {Tactical Air Control System/Tactical Air Defense System (TACS/TADS), Ground Amphibious Management Organization (GAMO), Tri Service Tactical Communications (TRITAC)}. Exercise information indicated some compatibility problems related to communication and integration, including TACP equipment, emergency and unconventional warfare CAS control without a FAC, DASC substitution procedure uncertainty, air defense coordination (lower levels), airspace management {interface of the CRC, Flight Operations Center (FOC), and Flight Coordination Center (FCC)}, tactical position coordinate information, apportionment and allocation conferences, fragmentary order timeliness, and F-4D/ASRT compatibility.

k. Objective No. 11 - New/Improved Equipment. Equipment improvements, introduced for night/reduced weather CAS, were the improved ASRT (automatic guidance commands and improved acquisition capabilities), F-111 radar/beacon employment using standard TACS elements and Air Alert Divert target assignment, and AC-130 capabilities. These demonstrated operational feasibility for responsive and effective night all weather CAS, although a few problems remain. Programmed modernization will materially improve CAS command and control capability.

4. COMPARISON WITH JSTF ESTIMATES.

a. Comparison with elapsed time estimates contained in the JSTF study, which addressed a goal of 25 percent of emergency immediate missions complete in 15 minutes, 75 percent in 20 minutes, and 100 percent in 45 minutes, was accomplished although differing methodologies and exercise constraints make the comparisons approximate at best. In general, the Army/Air Force command and control network demonstrated a capability to meet the criteria and estimates using a mix of paths as indicated by the JSTF, with times generally comparable to applicable estimates. The tables noted below show only exercise mean times for approximate comparison. The utility, however, of determining responsiveness based on a response time criterion without concomitant consideration of mission effectiveness in terms of lethality and survivability remains questionable.

(1) Table 1 shows exercise average total mission response times for base case. All samples without delays averaged less than JSTF estimates. Paths 2 and 4 (DASC Air Alert) essentially matched or bettered JSTF estimates for 25 percent of the total samples (16.1 and 10.8 minutes respectively) but then began to show the effects of exercise aircraft queuing, controller, and ground authority delays. Tactical Air Control Center (TACC) control of assets (Paths 5, 6, and 7) showed faster TACC processing than envisioned by the JSTF. Paths 1 and 5 (Ground Alert) show effects of average exercise basing (50-60 NM compared to JSTF NATO scenario basing (about 100 to 250 NM).

(2) Table 2 shows average exercise base case element-to-element link times compared to JSTF estimates. Forward Air Controller (FAC) to target times reflect mainly the lack of target marking/designation authorization, and ground authority clearance delays. With the above exceptions, most undelayed samples and total samples bettered their estimates.

(3) Table 3 shows average total processing times (which include the entire terminal controller-to-target link time), communication times (request phase only), and transit times. Processing times were about 0.5 to 1 minute less than shown due to "uncollected" communication time, and communication time is thus understated by about the same amount. As the JSTF indicated, processing requires improvement, which is anticipated in programmed modernization of the TACS. Transit times reflect the JSTF/Exercise basing distances plus holding point differences, and exercise and operational delays.

b. Comparison with the other JSTF criteria and estimates is included in the main report, in that many of the factors have been addressed relative to the CAS Objectives.

Army/Air Force Total Mission Response Time Comparison - In Minutes - Base Case

NETWORK: ARMY/AIR FORCE COMMAND AND CONTROL NETWORK FOR CAS

PATH DESCRIPTION		POOL	NO. SAMPLES	EXERCISE DATA MEAN	JSTF ESTIMATE EXPECTED TIME
Path 1:	REQUESTOR-DASC-TUOC-GROUND-TCL	H TOT	34	30.5	40.0
		H W/O	9	21.7	
		H DEL	25	33.7	
Path 2:	REQUESTOR-DASC-CRC/CRP/FCP-AIR-TCL	H TOT	22	22.0	17.8
		H W/O	5	16.4	
		H DEL	17	23.6	
Path 3:	REQUESTOR-DASC CRC/CRP/FCP-DIVERT-TCL	H TOT	11	19.7	20.2
		H W/O	4	17.3	
		H DEL	7	21.1	
Path 4:	REQUESTOR-DASC-AIR-TCL	H TOT	77	18.5	16.3
		H W/O	31	12.1	
		H DEL	46	22.9	
Path 5:	REQUESTOR-DASC-TACC-TUOC-GROUND-TCL	H TOT	13	26.9	49.3
		H W/O	5	19.4	
		H DEL	8	31.5	
Path 6:	REQUESTOR-DASC-TACC-CRC/CRP/FCP-AIR-TCL	H TOT	26	25.9	27.1
		H W/O	8	14.4	
		H DEL	18	30.9	
Path 7:	REQUESTOR-DASC-TACC-CRC/CRP/FCP-DIVERT-TCL	H TOT	12	21.4	29.5
		H W/O	3	12.7	
		H DEL	9	24.3	

TUOC: Tactical Unit Operations Center
TCL: Terminal Controller (FAC, ASRT)
FCP: Forward Air Control Post

H TOT: Total Complete Missions
H W/O: Complete Missions without Delays
H DEL: Complete Missions with Delays Included

Table 1

Army/Air Force C&C Element Link Time Comparison - In Minutes - Base Case

NETWORK: ARMY/AIR FORCE COMMAND AND CONTROL NETWORK FOR CAS

NODE TO NODE	POOL	EXERCISE DATA SAMPLES	EXERCISE DATA MEAN	JSTF ESTIMATE EXPECTED TIME
REQUESTOR-DASC	H TOT	188	3.1	3.3
	H W/O	150	2.4	
	H DEL	38	6.1	
DASC-CRC/CRP/ FCP (AIR ALERT)	H TOT	22	5.3	7.2
	H W/O	19	4.8	
	H DEL	3	8.3	
DASC-TACC	H TOT	33	4.6	9.3
	H W/O	27	4.2	
	H DEL	6	6.2	
TACC-TUOC	H TOT	13	1.9	7.2
	H W/O	13	1.9	
	H DEL	0	-	
TACC-CRC/CRP/ FCP (AIR ALERT)	H TOT	16	4.2	7.2
	H W/O	13	4.1	
	H DEL	3	4.7	
CRC-FLIGHT LEADER (AIR ALERT)	H TOT	37	2.9	1.5
	H W/O	31	1.6	
	H DEL	6	10.0	
FAC(G)-TARGET	H TOT	30	4.4	3.5
	H W/O	22	3.5	
	H DEL	8	6.8	
FAC(A)-TARGET	H TOT	165	4.6	3.5
	H W/O	121	3.0	
	H DEL	44	9.1	
DIVERT-FAC(A)	H TOT	22	3.9	4.7
	H W/O	17	2.1	
	H DEL	5	10.2	

Table 2

Army/Air Force Processing, Communication, and Transit Comparison - In Minutes - Base Case

NETWORK: ARMY/AIR FORCE COMMAND AND CONTROL NETWORK FOR CAS

	PATH DESCRIPTION	POOL	EXERCISE DATA			JSTF ESTIMATE		
			PROCESSING	COMM	TRANSIT	PROCESSING	COMM	TRANSIT
Path 1	REQUESTOR-DASC-TUOC-GROUND-TCL	H TOT	17.4	1.6	11.5	15.0	4.7	20.3
Path 2	REQUESTOR-DASC-CRC/CRP/FCP-AIR-TCL	H TOT	12.7	2.6	5.7	10.1	5.5	2.2
Path 3	REQUESTOR-DASC-CRC/CRP/FCP-DIVERT-TCL	H TOT	16.1	1.4	1.7	10.5	6.3	3.4
Path 4	REQUESTOR-DASC-AIR-TCL	H TOT	12.0	1.8	3.2	9.6	4.8	1.9
Path 5	REQUESTOR-DASC-TACC TUOC-GROUND-TCL	H TOT	16.5	2.3	8.0	21.3	8.0	20.0
Path 6	REQUESTOR-DASC-TACC-CRC/CRP/FCP-AIR-TCL	H TOT	15.2	3.3	6.2	15.4	9.1	2.6
Path 7	REQUESTOR-DASC-TACC CRC/CRP/FCP-DIVERT-TCL	H TOT	11.6	4.0	6.1	14.0	9.0	8.0

Table 3

PART III

ARMY COMMAND AND CONTROL NETWORK FOR ATTACK HELICOPTER SUPPORT

1. GENERAL. Following is a summary of the AHS data from Exercises BRAVE CREW 74, BRAVE SHIELD IX, GALLANT SHIELD 75 and SOLID SHIELD 75. The AHS data from Exercise REFORGER 74 was not included due to the limited amount of useable data obtained because of operational, environmental, and logistical problems discussed in detail in Volume V.

2. DATA INVENTORY. There were 888 AHS requests generated during the four exercises. Of those, 75 were disapproved, 78 were cancelled and 174 were lacking data upon which to base mission classification. The remaining 561 missions were flown and produced 370 complete missions (those missions with a recorded request time and weapons release time as well as times for critical nodes in between). Of the 370 complete missions, 194 were recorded during base case conditions and 176 were recorded during deviation conditions. There were 191 missions flown that were assessed as not complete because the missions were not comparable to JSTF path descriptions or were missing critical nodal or link data.

3. ANALYSIS BY OBJECTIVE. Each of the CAS Validation Objectives is addressed, using the empirical data collected, subjective comments of senior commanders participating in the exercises, and observations of JVH personnel.

a. Objective No. 1 - Response Time. The 370 total cumulative complete missions averaged 13.7 minutes, and the 232 complete missions without delays averaged 8.4 minutes. The largest number of complete missions (172) were flown on Path 2 (BNCP - DIVERT), the most responsive path, with an average response time of 8.8 minutes. The 121 Path 2 missions without delays averaged 5.6 minutes. Deviation conditions generally had little effect on response times because of the difficulty in attaining realistic deviation conditions. The greatest degradation of mission response time was caused by delays, with 138 (37%) complete missions containing delays.

b. Objective No. 2 - Communication Requirements. Eighteen percent (66 missions) of the complete missions encountered at least one communication delay. There were 38 missions with communication only delays, which averaged 18.2 minutes. Of all types of delays encountered, communication delays had the highest frequency of occurrence. Generally communication equipment appeared adequate; however, observations during the exercises indicated that reliability and redundancy of secure voice equipment required improvement. Jamming was highly effective against some forward unit FM nets, indicating the necessity for additional ECCM training.

c. Objective No. 3 - Integration. Fourteen percent of AHS missions encountered at least one integration delay. Missions with only integration delays averaged 16.8 minutes. While integration/coordination of AHS with artillery and air defense was accomplished satisfactorily, most of the delays were the result of human error and indicated the need to maximize the integration of attack helicopters with unit training.

d. Objective No. 4 - Systems Capacity. Because of exercise constraints, no attempt was made to test maximum system capacity. The command and control system did demonstrate a capability to process requests for AHS at rates greater than JSTF estimated would be required to meet the NATO scenario peak requirements. Fourteen requests were processed by a brigade command post in a 40 minute period. Fourteen percent of all complete missions encountered at least one capacity delay; however, the capacity delay groups included delays not purely associated with system capacity, such as communication net saturation. Most of the system capacity delays were related to non-availability of attack helicopter assets and procedural errors.

e. Objective No. 5 - Training. While this objective is a Service responsibility, the level of training and experience did have a major effect upon responsiveness as evidenced by the "learning curve" reflected in the data. AHS performance improved over the course of the exercise program.

f. Objective No. 6 - Night/Reduced Weather. Most of the weather deviation missions were flown during simulated conditions, and the night missions were flown primarily under Visual Flight Rules (VFR). Under these conditions, there was no degradation noted. High wind was the only weather condition which degraded AHS performance in CONUS exercises.

g. Objective No. 7 - Target Acquisition. There was a low frequency of occurrence of missions encountering target acquisition delays (7%). Additionally, many of the delays could be attributed to exercise artificialities.

h. Objective No. 8 - Damaged Elements. Due to the redundancy and flexibility of the normal command system, little degradation resulted from damaged elements. This was particularly true at the lower levels for which data were obtained. It is expected that some degradation would occur and some flexibility would be lost if brigade and higher level Command Posts (CPs) and tactical operations centers were destroyed.

i. Objective No. 9 - Intelligence/Friendly. Quantitative data were insufficient for analysis. Subjective comments indicated that adequate intelligence/friendly information was available to unit commanders and flight leaders through normal command and intelligence nets.

j. Objective No. 10 - Compatibility and Interoperability. No communications incompatibility delays were noted in the request histories of AHS missions. See Part II, paragraph 3j.

k. Objective No. 11 - New Improved Equipment. No new improved equipment was available for deployment to support AHS during the exercises.

4. COMPARISON WITH JSTF ESTIMATES. It is important to emphasize that the exercise data represent actual observed performance while the JSTF response times were based on estimates and experience. A general comparison of collected exercise data with the JSTF estimates indicated that the command and control network for AHS was capable of meeting the JSTF response time criterion under most conditions. In some cases the JSTF times were found to be optimistic, particularly in processing times. AHS was very responsive on exercises, compared to the NATO scenario JSTF goals of 25% mission completion in 15 minutes, 75% mission completion in 20 minutes, and 100% mission completion in 45 minutes. For example, less than three percent (11 missions) of the 370 complete missions were longer than 45 minutes. Eighty-two percent of AHS missions were completed in 20 minutes or less. Tables 4, 5, and 6 show a more detailed comparison of exercise data with JSTF estimates.

a. Table 4 presents total mission response time by path compared to the JSTF estimates, Paths 1, 3, 4, and 6 were slightly longer than the JSTF expected times while Paths 2 and 5 were shorter.

b. Table 5 presents selected link times compared to the JSTF estimates. Only three of the nine link times were longer than the JSTF estimates and those time differences were two minutes or less.

c. Table 6 presents the exercise base case path total communication, processing, and transit times compared to JSTF estimates. Exercise communications times were faster, transit times were close, even though transit distances were longer in some cases than the JSTF calculated, and processing times were longer than JSTF estimates in every case.

AHS - TOTAL MISSION RESPONSE TIME - CUMULATIVE					
	PATH		EXERCISE DATA SAMPLE	MEAN	JSTF ESTIMATES EXPECTED TIME
	1	H-TOT	84	11.3	10.5
(BNCP)		H-W/O	60	8.1	
(GROUND ALERT)		H-DEL	24	19.5	
	2	H-TOT	172	8.8	10.3
(BNCP)		H-W/O	121	5.6	
(DIVERT)		H-DEL	51	16.4	
	3	H-TOT	40	22.5	16.1
(BNCP-BDECP)		H-W/O	19	16.3	
(GROUND ALERT)		H-DEL	21	28.2	
	4	H-TOT	13	17.5	16.8
(BNCP-BDECP)		H-W/O	5	7.8	
(DIVERT)		H-DEL	8	23.5	
	5	H-TOT	37	20.5	23.3
(BNCP-BDECP-DTOC)		H-W/O	15	11.2	
(GROUND ALERT)		H-DEL	22	26.9	
	6	H-TOT	24	29.6	25.2
(BNCP-BDECP-DTOC)		H-W/O	12	22.9	
(DIVERT)		H-DEL	12	36.3	

BN: Battalion
BDE: Brigade
DTOC: Division Tactical Operations Center

Table 4

AHS - SELECTED ELEMENT LINK TIME COMPARISON - CUMULATIVE				
NODE TO NODE		EXERCISE DATA SAMPLE	MEAN	JSTF ESTIMATES EXPECTED TIME
BNCP-GND ALERT	H-TOT	82	1.7	2.0
	H-W/O	74	1.2	
	H-DEL	8	6.0	
BNCP-DIVERT	H-TOT	176	3.1	2.3
	H-W/O	144	1.2	
	H-DEL	32	12.0	
BNCP-BDECP	H-TOT	74	3.3	3.3
	H-W/O	65	2.7	
	H-DEL	9	7.3	
BDECP-DTOC	H-TOT	56	2.4	6.5
	H-W/O	49	1.6	
	H-DEL	7	7.9	
BDECP-GND ALERT	H-TOT	61	4.3	4.3
	H-W/O	47	2.9	
	H-DEL	14	9.1	
DTOC-GND ALERT	H-TOT	38	2.4	5.0
	H-W/O	33	2.1	
	H-DEL	5	4.8	
GND ALERT-CONTROLLER	H-TOT	178	8.2	6.2
	H-W/O	136	5.0	
	H-DEL	42	18.6	
DIVERT-CONTROLLER	H-TOT	184	3.7	5.7
	H-W/O	165	2.7	
	H-DEL	19	12.0	
CONTROLLER-TARGET	H-TOT	365	2.8	2.3
	H-W/O	345	2.4	
	H-DEL	20	10.6	

Table 5

PATH	EXERCISE DATA COMM	EXERCISE DATA PROCESSING	EXERCISE DATA TRANSIT	JSTF ESTIMATES COMM	JSTF ESTIMATES PROCESSING	JSTF ESTIMATES TRANSIT
1 BNCP (GROUND ALERT)	1.8	5.8	5.4	1.5	3.5	5.5
2 BNCP (DIVERT)	0.7	5.9	3.8	1.5	4.3	4.5
3 BNCP-BDECP (GROUND ALERT)	2.7	10.1	7.1	5.5	5.0	5.6
4 BNCP-BDECP (DIVERT)	2.1	8.0	6.7	6.2	5.0	5.6
5 BNCP-BDECP-DTOC (GROUND ALERT)	1.5	10.5	5.7	8.0	9.7	5.6
6 BNCP-BDECP-DTOC (DIVERT)	3.7	18.8	8.8	10.4	9.2	5.6

AHS - COMMUNICATION, PROCESSING, AND TRANSIT TIMES - BASE CASE

Table 6

PART IV

NAVY/MARINE CORPS COMMAND AND CONTROL NETWORK FOR CLOSE AIR SUPPORT

1. GENERAL. The following discussion summarizes the Navy/Marine Corps data collected on exercise EXPRESS CHARGER, AGATE PUNCH, and SOLID SHIELD 75.

2. DATA INVENTORY. The data inventory by exercise is contained in Volumes III, VII, and VIII. Following is a summary of the total data inventory.

a. Afloat Phase. This phase was exercised on only AGATE PUNCH and SOLID SHIELD. AGATE PUNCH comprises 92 percent of the data base. There were 607 emergency immediate Tactical Air Requests (TARs) submitted; 193 were disapproved, 54 were cancelled, and 356 were flown. The final disposition of four was unknown. Complete data were obtained on 336 of these -- 130 under base case and 206 under deviation conditions.

b. Ashore Phase. This phase was exercised on all LANTCOM sponsored exercises. There were a total of 1086 emergency immediate TARs submitted; 154 were disapproved, 115 were cancelled, 802 were actually flown, and the final disposition of 15 was unknown. Complete data were obtained on 707 of these; 280 from EXPRESS CHARGER, 270 from AGATE PUNCH, and 157 from SOLID SHIELD 75. Of the 707 missions, 317 were flown under base case conditions and 390 under deviation conditions.

3. ANALYSIS BY OBJECTIVE. Details of the following discussions by CAS Validation Objectives are in Section IV and Annex G.

a. Objective No. 1 - Response Time. Delays were the most significant variable, occurring in 92 percent of all missions with control afloat and in 70 percent with control ashore. The frequency of occurrence of delays in missions during the ashore phase progressed from .51 during EXPRESS CHARGER to .85 during SOLID SHIELD. Because the path and deviation mixture varied so much between exercises, each exercise must be examined in detail for a thorough understanding of the ashore phase data. Total mission response time for the 336 cumulative control afloat missions averaged 40.8 minutes (21.4 minutes for the 27 missions without delays). The fastest base case response was provided by Path 9 (Air Alert) which averaged 36.2 minutes (17.0 without delays). With control ashore, the 707 cumulative missions averaged 31.6 minutes (16.1 without delays). The fastest base case path (Path 11, Ground Alert-forward) averaged 15.5 minutes (11.2 without delays). The deviations which adversely affected response times were damaged elements, ECM, and target rich during the afloat phase and weather, night, target rich, and ECM during the ashore phase.

b. Objective No. 2 - Communications. Examination of the data on the deviation conditions relevant to this objective indicated that secure voice had little or no response time effect. ECM apparently had a significant adverse effect - six minutes in the afloat phase and up to 22 minutes in the ashore phase. Delays related to this objective comprised the largest single group of causes, occurring in 43 percent of the afloat missions and 51 percent of the ashore missions. The apparent Total Mission Response Time (TMRT) increase attributable to this group of delays was 10.4 minutes in the afloat phase and 14.5 minutes in the ashore phase. Overall, the network communications were adequate to accomplish the mission; however, repeated delays in the request nets and the terminal control nets indicated a requirement for improvements.

c. Objective No. 3 - Integration. The deviations pertinent to this objective are air threat and air defense threat. Because of the difficulties in simulating these deviations, exercise data were inconclusive. Delay data constituted the primary data source for this objective. Delays grouped for this objective caused a 15.7 minute increase on Path 9 (afloat) and a 13.8 minute increase over cumulative horizontal non-delayed missions ashore. All required integration functions were performed in a satisfactory manner. During the afloat phase, these functions were realistically performed. During the ashore phase, only those actually required were performed. Improvements are required in maintenance of near real time resource status in both the Supporting Arms Coordination Center (SACC) and the Direct Air Support Center (DASC).

d. Objective No. 4 - Capacity. Maximum capacity was neither tested nor reached. Target Rich deviation missions provided a measure of response times during periods of high activity. These missions were generally longer than base case, but no precise measure of the length was feasible. Many of the delays categorized under this objective were more closely related to exercise airspace constraints than to capacity. For instance, most missions were concluded with multiple pass target attacks for training purposes. This increased the capacity delays related to terminal area airspace constraints. The apparent response time increase attributable to these delays was 11.8 minutes in the afloat phase and 12.1 minutes in the ashore phase; both figures are in comparison to cumulative complete missions without delays. The network demonstrated a sustained capability to process requests at levels commensurate to those envisioned by the JSTF. The total network processed 1693 requests, 1158 of which were flown, in less than 26 exercise days.

e. Objective No. 5 - Training. Although designated a Service responsibility, observations verified that the level of training was a major variable in response times. This effect became more pronounced as the level of activity and imposition of unfamiliar paths increased -- particularly during the ashore phase. A positive learning curve was evident in most of the exercises.

f. Objective No. 6 - Night/Reduced Weather. The network demonstrated the capability to routinely conduct operations during these conditions. During the afloat phase, there were 45 complete night missions executed. These showed an increase of two to four minutes over base case (H TOT) times. There were insufficient weather data for comparison in the afloat phase. During the ashore phase there were 180 complete night missions executed. These data indicate that if the same type missions are compared, the ones conducted at night are slightly longer. There were 29 complete, actual weather missions conducted during the ashore phase. These missions were approximately twice as long as base case missions without delays.

g. Objective No. 7 - Target Acquisition. Data were limited to terminal area activities. Most of the recorded delays attributable to this objective were more closely related to exercise constraints than to operational factors. During the afloat phase, these delays lengthened the terminal area times by 4.5 minutes, compared to base case times without delays. During the ashore phase, these delays added about 13.2 minutes to the cumulative complete missions average without delays. Since the delays were so highly exercise related, these data have a low order of confidence. Overall, the network capability for target acquisition exercise conditions was satisfactory.

h. Objective No. 8 - Damaged Elements. Deviation data relative to this objective show little difference in TMRT over other similar type missions; however, sample sizes are small. Most notable during the periods in which a major node was out of action was the much lower rate of complete missions. This was apparently caused by fewer requests once it was realized the node was inoperative and a lack of clearcut procedures to be followed, particularly in the ashore phase. Provisions for catastrophic failure in the TACC afloat, such as increased emergency communication capability and the presence of a backup facility (TADC) appear necessary. Provisions ashore for backup facilities and procedures to be followed when a major node is out of operation also require improvement.

i. Objective No. 9 - Intelligence/Friendly Information. During the afloat phase only eight of 336 complete missions were affected by delays grouped with this objective. During the ashore phase 13 of 707 missions were so delayed. These numbers are not adequate for estimation of elapsed time effects. They do, however, tend to reinforce the observation that the network adequately performed the functions relevant to this objective.

j. Objective No. 10 - Compatibility/Interoperability. There were no indications of incompatibility other than the communication areas discussed under Objective No. 2. These problems cannot be confirmed as directly relevant to this objective No. 10. The network did operate a rather extensive Marine Tactical Data System (MTDS)/Naval Tactical Data System (NTDS) digital data links with high accuracy and reliability.

k. Objective No. 11 - New/Improved Equipment. No new or improved equipment was employed within the network during the exercises.

4. COMPARISON WITH JSTF CAS STUDY, PHASE II. This paragraph discusses the JSTF immediate mission response time criteria in terms of the data collected on the Navy/Marine Corps network for CAS. Tables 7 through 12 are summary comparisons of the exercise data with the JSTF estimates. Differing methodology in development of the two sets of data raises some fundamental questions as to their comparability. The exercise data used are base case complete missions. The use of either set of JSTF estimates or exercise data to predict actual capability is dangerous because of the methodologies used and the impact of exercise constraints during the particular exercises employed in this program. The data are in general comparable to the JSTF estimates and indicate that there is nothing inherent in the network to preclude meeting the response time criteria. The primary reason for some response times exceeding the criteria was the high incidence of delays, many of which were directly exercise related.

NAVY/MARINE CORPS TOTAL MISSION RESPONSE TIME COMPARISON - BASE CASE AFLOAT (BY TIME COMPLETE)

NETWORK: NAVY/MARINE CORPS COMMAND AND CONTROL NETWORK FOR CAS (AFLOAT)

		EXERCISE DATA		JSTF ESTIMATE
PATH DESCRIPTION	POOL	NO. SAMPLES	MEAN TIME	EXPECTED TIME
REQUESTOR-SACC/TACC-DECK ALERT (PATH 7)	H W/O	1	40	
	H DEL	19	45.7	
	H TOT	20	45.5	64
REQUESTOR-SACC/TACC-DIVERT (PATH 8)	H W/O	2	17	
	H DEL	10	40	
	H TOT	12	36.2	37
REQUESTOR-SACC/TACC-AIR ALERT (PATH 9)	H W/O	8	19.5	
	H DEL	83	38.4	
	H TOT	91	36.7	18

Table 7

NAVY/MARINE CORPS C&C ELEMENT LINK TIME COMPARISON - BASE CASE - AFLOAT

NETWORK: NAVY/MARINE CORPS COMMAND AND CONTROL NETWORK FOR CAS (AFLOAT)

		EXERCISE DATA		JSTF ESTIMATE
NODE-TO-NODE	POOL	NO. SAMPLES	MEAN TIME	EXPECTED TIME
REQUESTOR-SACC	H W/O	106	1.8	
	H DEL	24	5.4	
	*H TOT	130	2.3	3.3
SACC/TACC-DECK ALERT	H W/O	14	8.5	
	H DEL	5	22	
	H TOT	19	11.6	7.2
SACC/TACC-AIR ALERT	H W/O	22	12.2	
	H DEL	67	23.5	
	H TOT	89	20.7	7.2
DECK ALERT-FAC(G)	H W/O	3	17.7	
	H DEL	9	29.3	
	H TOT	12	24.9	50
AIR ALERT-FAC(G)	H W/O	36	3.1	
	H DEL	26	11.4	
	H TOT	62	4.8	4
AIR ALERT-FAC(A)	H W/O	17	4.2	
	H DEL	7	12.6	
	H TOT	24	4.8	4
TCL-TGT-FAC(G)	H W/O	76	3.2	
	H DEL	12	6.2	
	H TOT	88	3.1	3.5
TCL-TGT-FAC(A)	H W/O	28	3.8	
	H DEL	6	8.7	
	H TOT	34	3.9	3.5

*Failed "Goodness-of-Fit" test.

Table 8

POOLED DATA/JSTF STUDY COMPARISON - AFLOAT (SELECTED TIMES)

NETWORK: NAVY/MARINE CORPS COMMAND AND CONTROL NETWORK FOR CAS (AFLOAT)

		EXERCISE DATA			JSTF ESTIMATE		
PATH DESCRIPTION	POOL	COMM	PROCESSING	TRANSIT	COMM	PROCESSING	TRANSIT
REQUESTOR-SACC-TACC-DECK ALERT (PATH 7)	H TOT	2.7	22.5	20.6	4.5	8.5	51.0
REQUESTOR-SACC/TACC-DIVERT (PATH 8)	H TOT	3.6	20.7	6.7	3	8.5	25.5
REQUESTOR-SACC/TACC-AIR ALERT (PATH 9)	H TOT	2.9	27.3	6.5	5	10	3

Table 9

NAVY/MARINE CORPS TOTAL MISSION RESPONSE TIME COMPARISON - BASE CASE - ASHORE (BY TIME COMPARISON)

NETWORK: NAVY/MARINE CORPS COMMAND AND CONTROL NETWORK FOR CAS (ASHORE)

PATH DESCRIPTION	POOL	EXERCISE DATA NO. SAMPLES	EXERCISE DATA MEAN TIME	JSTF ESTIMATE EXPECTED TIME
REQUESTOR-DASC-GROUND ALERT FORWARD (PATH 1)	H W/O	7	13.3	
	H DEL	13	38.1	
	H TOT	20	29.4	Not Comparable
REQUESTOR-DASC-AIR ALERT (PATH 2)	H W/O	36	12.1	
	H DEL	53	31.4	
	H TOT	89	23.6	17
REQUESTOR-DASC-GROUND ALERT (PATH 3)	H W/O	50	17.2	
	H DEL	54	26.8	
	H TOT	104	22.2	22.5
REQUESTOR-DASC-TACC-DIVERT (PATH 4)	H W/O	3	21.3	
	H DEL	21	56.4	
	H TOT	24	52	28.6
REQUESTOR-DASC-TACC-GROUND ALERT (PATH 5)	H W/O	6	17.7	
	H DEL	21	43.8	
	H TOT	27	38	35.8
REQUESTOR-DASC-TACC DECK ALERT (PATH 6)	H W/O	1	58	
	H DEL	11	55.6	
	H TOT	12	55.8	74.5
REQUESTOR-REG'T FSCC-GROUND ALERT FORWARD (PATH 11)	H W/O	10	11.2	
	H DEL	2	37	
	H TOT	12	15.5	15.1

TACC: Tactical Air Control Center

Table 10

NAVY/MARINE CORPS C&C ELEMENT LINK TIME COMPARISON - BASE CASE - ASHORE

NETWORK: NAVY/MARINE CORPS COMMAND AND CONTROL NETWORK FOR CAS (ASHORE)

NODE-TO-NODE	POOL	EXERCISE DATA NO. SAMPLES	EXERCISE DATA MEAN TIME	JSTF ESTIMATE EXPECTED TIME
REQUESTOR-DASC	H W/O	221	1.5	
	H DEL	83	7.0	
	H TOT	304	3.0	3.3
DASC-GROUND ALERT (FWD)	H W/O	13	3.6	
	H DEL	7	30.7	
	H TOT	20	13.1	Not Comparable
DASC-GROUND ALERT	H W/O	96	2.7	
	H DEL	6	8	
	H TOT	102	3	7.2
DASC-AIR ALERT	H W/O	23	4.1	
	H DEL	21	21.1	
	H TOT	44	12.2	7.2
DASC-TACC	H W/O	60	3.7	
	H DEL	22	21.6	
	H TOT	82	8.5	8.2
GROUND ALERT - TCL	H W/O	96	10.1	
	H DEL	34	21	
	H TOT	130	13	8.5
GROUND ALERT (FWD) - TCL	H W/O	27	6.6	
	H DEL	5	16.8	
	H TOT	32	8.2	Not Comparable
DECK ALERT-TCL	H W/O	5	28	
	H DEL	7	37.4	
	H TOT	12	33.5	Not Comparable
AIR ALERT-FAC(G)	H W/O	51	3.9	
	H DEL	15	14.9	
	H TOT	66	6.4	3
AIR ALERT-FAC(A)	H W/O	16	4.1	
	H DEL	10	12.8	
	H TOT	26	7.4	3
TCL-TGT-FAC(G)	H W/O	190	3.4	
	H DEL	17	8.9	
	H TOT	207	3.9	3.5
TCL-TGT-FAC(A)	H W/O	69	3.9	
	H DEL	12	9.3	
	H TOT	81	4.7	3.5

Table 11

POOLED DATA/JSTF STUDY COMPARISON - ASHORE (SELECTED TIMES)

NETWORK: NAVY/MARINE CORPS COMMAND AND CONTROL NETWORK FOR CAS (ASHORE)

PATH DESCRIPTION	POOL	EXERCISE DATA			JSTF ESTIMATE		
		COMM	PROCESSING	TRANSIT	COMM	PROCESSING	TRANSIT
REQUESTOR-DASC-GROUND ALERT FORWARD (PATH 1)	H TOT	3.8	17	5.8	1.5	3.7	4.3
REQUESTOR-DASC-AIR ALERT (PATH 2)	H TOT	3.8	12.1	6.7	4	10	3
REQUESTOR-DASC-GROUND ALERT (PATH 3)	H TOT	3.3	11.1	7.3	4	10.5	8
REQUESTOR-DASC-TACC-DIVERT (PATH 4)	H TOT	5.9	25.3	12.5	8	14.5	6.1
REQUESTOR-DASC-TACC-GROUND ALERT (PATH 5)	H TOT	5.4	19.8	12.8	8	15	12.8
REQUESTOR-DASC-TACC-DECK ALERT (PATH 6)	H TOT	6.5	20.6	28.83	9.5	14.5	50.5
REQUESTOR-REG'T FSCC-GROUND ALERT FORWARD (PATH 11)	H TOT	2.3	9.2	4.0	2.5	6.5	6.1

Table 12

PART V

SUBJECTIVE COMMENTS

1. GENERAL. Participating exercise commander, command, and component comments on the exercises, apportionment and allocation (USAF), survivability, the test objectives, and the final report, are summarized in Section V and contained in ANNEX D and Volumes II-VIII. Classified comments, analysis and bibliography submitted by HQ USAF, and bibliographies submitted by HQ US ARMY and HQ US NAVY are contained in the classified supplement (SECRET) to ANNEX D, Volume I. Following are the USREDCOM and LANTCOM subjective comments on the program.

2. USREDCOM COMMENTS.

a. The exercise environment for CAS Validation was not completely adequate to provide sufficient data to fully address all test objectives. Exercise artificialities/restrictions, such as restricted ground maneuver areas and airspace, no live fire, safety constraints, target marking restrictions, and focus on exercise training objectives, had a definite impact on the data collected. The scope of the exercises and limited forces and areas precluded examination of large scale integration/coordination and interoperability/compatibility at the higher echelons of command.

b. The command and control systems for CAS/AHS were generally the same and were employed in essentially the same manner as described in the JSTF Study, however, evolutionary changes in tactics, techniques, and procedures have occurred. Also, changes such as employment of an improved ASRT; use of F-111's with radar beacons; use of AC-130's, and the absence of the A-10 and the advanced attack helicopter, are reflected in CAS Validation results.

c. Response time alone does not constitute a completely valid overall judgment of a CAS command and control system. Responsiveness should include mission effectiveness in terms of lethality, survivability, and contribution to total force effectiveness.

d. The flexibility of the command and control systems for CAS to mass firepower in support of the ground commanders at the point where it is needed was not demonstrated in the CAS exercises due to the relatively small forces and areas available.

e. Possibly the greatest value realized from the CAS Validation Program has been the improved training that command and control personnel of all services have received as a result of the increased command emphasis placed on CAS/AHS. USREDCOM component commanders are continuing this emphasis during readiness training exercises.

f. Extensive effort is underway in USREDCOM components to perfect coordination of airspace management. Considerable progress has been made thus far in resolving long standing problems and the outlook is encouraging.

g. With regard to survivability of command and control networks and aircraft systems employed by these networks, recent combat situations in conditions of high air defense threat have emphasized the need to re-examine procedures employed in implementation of CAS and AHS. Such examination is in progress within USREDCOM components as exemplified by the review of Tactical Air Control Party organization and employment and the study of the Air Mobile Division.

h. Although currently available systems were deployed for CAS Validation Program exercises, information gathered in the course of the validation is encouraging in terms of programmed modernization, with beneficial results expected for both CAS/AHS effectiveness and timeliness. Fiscal and developmental support of such programs is highly encouraged from the standpoint of an operating command such as USREDCOM.

i. While CAS Validation has demonstrated the problems associated with piggy backing tests on joint exercises, resource constraints and the advantages of the exercise environment support consideration of this option. Nevertheless, the impact of such tests both on constrained resources and on exercise operations warrants careful scrutiny of the worth of such testing before approval.

3. LANTCOM COMMENTS.

a. The Close Air Support (CAS) Validation Program did not adversely affect the overall training accomplishments of the exercises during which it was conducted. On the contrary, it focused attention on the CAS networks and actually increased the level of training in this aspect of the exercises. However, as outlined in further detail below, this forced command attention on CAS (in particular response times), and did affect the data collected. These effects manifested themselves in both shorter and longer response times. Some of the effects were caused by perceptions of evaluation requirements by the exercise participants, some by scenario changes to influence the CAS play, while the largest were probably unrealistic commanders' decisions which were made either to enhance response times or to satisfy specific CAS validation requirements. The unrealistic response time decisions fall in the general categories of aircraft apportionment and allocation, equipment siting to enhance communications, and procedures designed to minimize time. The actions taken to satisfy specific requirements involved dictating certain network paths, taking unusual actions to create deviations from base case conditions, and pressing for a large enough volume of requests to provide the desired quantity of missions. An additional aspect which influenced data was the augmentation made possible because most of the exercises were of limited scale. This augmentation included equipment, repair parts, and personnel. This was present to varying degrees in every exercise and certainly had an impact on the CAS play. The extent of this impact cannot be quantified, but undoubtedly served to enhance the overall functioning of the CAS networks. None of the foregoing effects are quantifiable, nor always recognizable. The presence of these factors, however, did influence the data and are important to a thorough understanding of the significance of the reported results.

b. In this same context, all data should be recognized for exactly what it is--a reflection of what happened during specific exercises. It is not necesarily a reflection of what might be done in combat and should not be extrapolated to fit a given combat scenario. It should, however, be useful in helping to isolate some potential problem areas and to give some indication of each network's capabilities.

c. The factors discussed above detract from the overall validity of the report. As previously stated, the times do not represent absolute measures of capability and should not be used for such a measure. Much of the program's benefit was obtained prior to the reporting phase. The value gained by the Services in experiencing this scrutiny of their CAS systems probably surpasses any real value to be derived from the report itself.

d. Lethality, survivability, and some other aspects normally associated with overall responsiveness were not addressed by the validation. Although these are important aspects of CAS, they are only tangentially related to the command and control systems and not a proper subject for this investigation.

e. The following conclusions can be drawn subjectively from the data, from observing the exercises, and from interviewing participants in various exercises:

(1) All command and control systems are capable of performing their required functions in providing close air support.

(2) Equipment inadequacies, except as noted below, accounted for a very few of the problems encountered.

(3) All systems must continue to seek improvement particularly in the areas of procedures and organization.

(4) The single factor that made the most difference in the functioning of the systems was the state of training and experience of the personnel at each network node. (Although training has been relegated to the Services to address, this program report would be remiss in omittting it, since it was a major factor.)

(5) There is a serious inadequacy in the Army/Air Force, Marine Corps, and to a lesser degree in the Navy networks in that there is no clear-cut procedure to be followed when the DASC/SACC becomes a casualty. This was particularly evident when the DASC was declared a casualty during exercise play.

4. USREDCOM COMMENTS REGARDING WSEG REPORT. Both the USREDCOM/LANTCOM and the WSEG Reports used the same data base, thus the average elapsed time statistics for element to element performance are the same; the primary differences in the two reports are the analytic techniques used and the assessment of the objectives.

a. There are several differences in analytic technique used in the reports.

(1) WSEG concentrated on a detailed statistical analysis of the element to element performance of the command and control systems for CAS and AHS, and then combined these results to illustrate system performance for complete mission paths. The USREDCOM approach to analysis was to use both the complete mission data, and the element-to-element link data, to determine response times and the location and cause of system problems.

(2) The WSEG allocation of the causes of network performance degradation (delays, disapprovals, cancellations, and aborts) to the various CAS validation objectives, differs somewhat from the two such allocations used in REDCOM analysis, with resultant differences in assessment of CAS validation objectives.

(3) WSEG also used a delimiting process in the analysis of command and control system delays. Delays recorded by data collectors were not used in the WSEG regression analysis unless the link time in which the delay occurred was longer than the mean plus one standard deviation. This technique reduced the frequency of occurrence of most delays, increased statistical indications of the elapsed time effect of most delays, and increased the average elapsed time values for performance without delays. USREDCOM/LANTCOM considered that the utility of the occurrence of reported delays outweighed the advantages of the WSEG screening, in terms of providing information to assist in addressing the CAS objectives other than response time.

(4) Regression analysis, employed in both reports to assist in attributing elapsed time effect to various causes or CAS "variables", was conducted somewhat differently. The REDCOM analysis used the Cumulative complete mission sample as a data base and investigated variation in total mission response time, on the grounds that elapsed time effects could be better determined using the relatively long dependent variable values associated with total mission response time, and the actual relationships of observed events inherent in complete missions. WSEG employed the individual element to element link samples, an approach which could be considered complementary to the REDCOM method. No information was available in the WSEG Report on regression analysis of variance measures to assist in determining suitability of models employed and confidence in elapsed time effects used.

(5) The USREDCOM report makes extensive use of qualitative and subjective information acquired during the program to balance the statistics, particularly with respect to the impact of exercise constraints and artificialities.

b. Relative to the WSEG findings, the following comments are offered:

(1) CAS Validation indicated that response times observed were generally in agreement with JSTF estimates for lower mission percentiles up through measures of central tendency, but that JSTF underestimated the impact of delays in those missions affected. Procedural causes were a factor, but for the most part equipment failure was not.

(2) The impacts of the communication, capacity, environmental, integration, and target acquisition related factors on network performance were assessed somewhat differently by REDCOM/LANTCOM based on the differences in analytic approach cited above.

(3) Relative to attainment of the CAS Validation Objectives, USREDCOM/LANTCOM considered that all objectives were attained within the limits of test design specified in test documentation and in consideration of available equipment and exercise constraints. In terms of target acquisition capability, it was considered sufficient for purposes of command and control verification, if the correct target was acquired by the aircrew, as evidenced by comparison of target location and description information. The utility of precise aircraft terminal area and attack position was more appropriate for testing aircraft systems in terms of weapon delivery accuracy and survivability, which was outside the scope of the CAS Validation Program.

c. Nevertheless, the WSEG Report was useful in reinforcing the statistical conclusions of the USREDCOM/LANTCOM Report especially since different analytical methodology was used. The assistance provided by WSEG in suggesting various analytical approaches to reduce the data collected was helpful in providing a meaningful report.

d. The WSEG Report has not been distributed to all addressees of the USREDCOM/LANTCOM Report. Requests for the WSEG Report should be directed to JCS/J-3.

PART VI

CONCLUSIONS

1. GENERAL. This section provides the conclusions of the CAS Validation Program, as a whole and by Service network.

a. The performance of the Service command and control networks for CAS and AHS has been validated in terms of the JSTF study criteria, and sufficient data and information provided to identify requirements for refinement of equipment, procedures, and training.

b. The program has served as an impressive training vehicle in the emphasis of CAS and AHS, and has enhanced capabilities of service participants.

c. The CAS Validation Program answered the test objectives, within the limits of current generation equipment and program constraints. Remaining aspects of the CAS Objectives, other than those involving large scale capacity, can be pursued individually by Services and Joint test organizations as equipment and procedures evolve.

d. The CAS Validation was limited in scope as a vehicle with which to verify the performance of command and control for CAS and AHS by peacetime exercise constraints, artificialities, and priority of exercise readiness training objectives.

e. Although limited in scope, the program provided the most suitable peacetime vehicle to address the CAS Objectives with a coordinated approach, due to the scale of the testing opportunity and the relative degree of realistic free play involved compared to a controlled test environment.

f. Response Time is but one factor in determining the effectiveness of command and control for CAS and AHS and must be considered in conjunction with lethality, flexibility, survivability, and capability to mass firepower.

2. ARMY/AIR FORCE CAS: The Air Force Tactical Air Control System demonstrated satisfactory capability, in coordination with related Army command and control elements, to effect flexible, responsive, and sustained command and control to concentrate air assets where required to optimize tactical air support of ground forces.

a. Objective No. 1 - Response Time: Response times for immediate CAS demonstrated a command and control capability, employing a mix of alert postures, to meet and in some cases better JSTF study estimates.

b. Objective No. 2 - Communications: Validation results indicated network communications were satisfactory at the levels of DASC and above, identified problems in the air request net, particularly involving TACP equipment, and supported the need for implementation of programmed AWACS and secure voice capabilities.

c. Objective No. 3 - Integration: Ability to integrate CAS with other tactical operations was satisfactory and requirements for improved fire support coordination, airspace management coordination, and air defense coordination were identified.

d. Objective No. 4 - Capacity. Although maximum network capacity was not tested, the command and control network demonstrated capability to handle requests and missions at greater levels than JSTF requirements.

e. Objective No. 5 - Training. Although training of the CAS command and control network was not evaluated (a service responsibility), CAS Validation highlighted training requirements through increased command emphasis on CAS procedures.

f. Objective No. 6 - Night/Reduced Weather. Data on night/reduced weather immediate CAS operation employing improved equipment (F-111 radar/beacon bombing, AC-130, and automatic ASRT), plus a limited sample of night visual CAS confirmed Army/Air Force network capability; some problems indicated areas for procedural improvement and practice.

g. Objective No. 7 - Target Acquisition. Data collection on principally terminal area handoff target acquisition confirmed accurate and responsive capability for visual CAS, prohibition of target marking and designation notwithstanding, but identified problems in handoff of timely and accurate target location information for all weather systems.

h. Objective No. 8 - Damaged Elements. Data confirmed effective and responsive redundancy in the TACS radar environment, but reinforced information on TACP equipment problems and indicated a need for practice of "DASC out" procedures.

i. Objective No. 9 - Intelligence/Friendly Information. Limited data confirmed adequacy of information to support the TACS from a wide variety of sources and little delay in the terminal area due to lack of such information.

j. Objective No. 10 - Compatability/Interoperability. Compatibility was generally effective throughout the network. Interoperability was not tested. Information indicated a few problems involving TACP capability, DASC substitution, lower level air defense coordination, airspace management interfaces, tactical position coordinates, and management procedures.

k. Objective No. 11 - New/Improved Equipment. Improvements introduced generally functioned well and problems were identified. USAF programmed modernization incorporating 485L equipment, AWACS, and other improvements should materially enhance command and control of CAS.

3. ARMY AHS. The Army method of task organizing organic weapons, including attack helicopters, to maneuver battalion and brigade level based on the tactical situation is a viable principle which assures unity of command and maximum decentralized execution. This type of task organization provides maximum direct support to maneuver battalions.

a. Objective No. 1 - Response Time. The response time data collect by the JVH indicated that the Army network for command and control of AH provided responsive support to maneuver commanders. Mission elapsed times were generally comparable to the JSTF estimates.

b. Objective No. 2 - Communication. Communication equipment, procedures and organizations were adequate and facilitated exchange of useful and timely information. Increased training of operator personnel and wider distribution of secure voice equipment among forward deployed units are essential to increase communications effectiveness. Attack helicopter units, do not possess sufficient radio equipment to conduct continuous operations from widely dispersed locations.

c. Objective No. 3 - Integration. Adequate procedures are in-being to insure prompt and continuous integration of AHS with other tactical operations, including the consideration of fire support coordination, air defense and airspace management functions. Identified problems in integration were due to exercise factors or "human error", in that established procedures were not uniformally followed.

d. Objective No. 4 - Capacity. The capacity of the command and control system to process a given number of requests is not a limiting factor in providing the desired numbers of target attacks to a ground commander under concentrated attack. Observation showed that the limiting factor was the number of helicopter assets available.

e. Objective No. 5 - Training. The objectives of determining training requirements and annual maintenance training was assigned as a Service responsibility. Status of individual and unit training had, however, a significant impact on system performance. The majority of these shortcomings identified during this program could be keyed, directly or indirectly, to the status of training. AHS system performance improved over the course of all exercises, indicating the need to know and practice established procedures.

f. Objective No. 6 - Night/Reduced Weather. Insufficient data were collected during reduced weather conditions to allow adequate analysis on which to base conclusions. AHS missions were conducted at night with little degradation.

g. Objective No. 7 - Target Acquisition. The use of target area simulations and other exercise artificialities affected the quality of data available to determine the ability of the target acquisition system to detect and identify targets. Observations indicated that established procedures were sound and target handoffs from ground controller to attack helicopter could be improved through increased team training.

h. Objective No. 8 - Damaged Elements. Data collected to determine the extent of system degradation resulting from damage to individual elements were limited to lower echelon organizations. Observations and data support the conclusion that little loss in system effectiveness resulted from damage to lower echelon elements due to inherent redundancy and overlap of functions among these echelons in the Command and Control System.

i. Objective No. 9 - Intelligence/Friendly Information. Intelligence and friendly information dissemination was adequate to support AHS.

j. Objective No. 10 - Compatibility and Interoperability. Compatibility of command and control elements directly involved in execution of AHS missions was satisfactory, although the need for improved coordination/communications between the Army FOC/FCC and lower echelon air defense elements and the TACS was noted.

k. Objective No. 11 - New/Improved Equipment. No new/improved equipment as defined by CAS program objectives was available for deployment for the exercises. Attack helicopters employed lacked the forward looking infrared system, stablilized optical sight, and doppler-inertial navigation capabilities envisioned in the JSTF study, with consequent effect on reduced visibility operation.

4. NAVY/MARINE CORPS CAS. The Navy/Marine Corps network demonstrated the capability to provide timely CAS at a sustained high rate over relatively long periods of time.

a. Objective No. 1 - Response Time. Most of the exercise times are comparable to the JSTF estimates, indicating that there is nothing inherent in the network which precludes meeting the criteria. Factors which caused some missions to be longer than the estimates were:

(1) Exercise airspace and safety constraints resulted in airspace saturation and queuing delays. These factors also reduce the comparability of the exercise data and JSTF estimates.

(2) Generating data on some of the prescribed JSTF paths required unusual measures since these paths are not normally used. This created confusion which aggravated operational delays.

b. Objective No. 2 - Communication Requirements.

(1) Communication requirements, as such were not tested, however, data indicate the network capability is adequate with certain areas which may require improvement.

(2) The air-to-ground communication in the terminal area merits further investigation.

(3) The frequency of communication related delays indicated a requirement for further study on equipment, maintenance, and/or training.

c. Objective No. 3 - Integration with Other Tactical Operations.

(1) The organization and procedures for integration exist within the network. However, because of exercise limitations and the unusual emphasis on CAS, little realistic integration was required or accomplished.

(2) In the TACC/SACC Afloat and the DASC Ashore, one of the most difficult tasks is maintaining and displaying, in near real-time, the current status and employment data of all CAS resources for use by the decision maker. At present, this is a manual operation that clearly merits investigation with a goal of improvement.

d. Objective No. 4 - Capacity. No attempt was made to measure absolute capacity. The network did demonstrate a sustained capability to process requests at higher levels than those envisioned by the JSTF. The primary limiting factor relative to this objective was terminal area airspace constraints rather than the command and control network.

e. Objective No. 5 - Training. The level of training/experience was a major factor in response times.

f. Objective No. 6 - Night/Reduced Weather. The networks demonstrated the capability to routinely operate under these conditions, with some increase in response time. Approximately one-fourth of the 1043 complete missions were conducted under either night or actual weather deviations.

g. Objective No. 7 - Target Acquisition. The network functioned effectively in the terminal area. Since exercise constraints affected this phase of the operation so severely, terminal area data were less reliable than most other exercise data.

h. Objective No. 8 - Damaged Elements. Provisions in the event of TACC/SACC failure afloat require improved communications and facilities. Provisions ashore for DASC backup facilities and procedures require improvement.

i. Objective No. 9 - Intelligence/Friendly Information. The limited data available tend to indicate that the network performed adequately the functions relevent to this objective.

j. Objective No. 10 - Compatibility/Interoperability. Compatibility was generally effective. The interoperability of the MTDS/NTDS data links was effective.

k. Objective No. 11 - New/Improved Equipment. No new/improved equipment was available for employment by the network on observed exercises.